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as on the contrary, Fishes living always in Water want no Eye-lids, because the same Water keeps their Eyes ever moist and clean; with which answer the Gentleman was satisfy'd. But I have since found that I was out in my assertion, for Flounders, Plaife, Soles, and I believe all flat Fishes can cover their Eyes; and if they had not, I fancy they would lose their Sight, because the said sort of Fish are not so nimble as others in Swimming being only able to move their Tails, the chief Instruments of Speed, upwards and downwards; wherefore these Fishes in a Storm don't betake themselves to the bottom of the Sea, as I am inform'd, but dig themselves holes in the Sand, which secures them from being cast upon the Beach or Strand: Now if they had not Eye-lids, the sharp points of Sand, whilst they are making their Nest, would wound the Tunicks of their Eyes, whereby the Transparency thereof would be destroy'd, and the Fishes become blind; which is a farther proof how perfect every Creature is in its own Species. I conclude, &c.

IV. *A Letter from Mr Antony van Leeuwenhoek, concerning the Tubes or Canals that convey the yellow Sap in the Herb called Chelidonium majus, or Celandine, &c.*

Delft in Holland, September 16, 1704.

THe Heer Peter Hotton, Professor in Physick and Botany at *Leyden*, and Fellow of the Royal Society, made me a Visit lately, and discoursing of several things, he desir'd me, that I would examin the *Chelidonium majus*, to wit, whether the Canals or Tubes that bring up the yellow Sap were distinguisht or separated from other Tubes;

I comply'd with his request, and imparted to him my poor Observations.

He return'd me an answer to that Letter, and at the same time sent me a Plant of the *Indian Fig*, upon which the *Cochineel Worm*, (for so the Professor calls those *Animalcula*) are to be found ; and the Leaves of two sorts of *Aloes*, to try whether there were in them several sorts of Tubes that bring up the *Yellow Sap*, &c.

I think it not improper to communicate to your Honourable Body my poor Remarks upon the same subject.

You must know then, that I first observ'd the external Skin or Membrane of the Leaves of *Aloes*, to discover, if possible, of what Tubes or Pipes they were compos'd ; but do what I could, I was not able to find out the Conjunction of the Parts, because that Membrane was so weak and tender, that it always broke without any remarkable Discovery.

In this Disquisition I observ'd that in the said Membrane there lay, as it were prest in roundish Particles that look'd like little Bladders, and in those little Bladders, green Particles, that had a Sap in 'em ; and they lay as it were in a right Line, and so interwoven with each other, that they serv'd (as I imagin'd) for Tubes or Canals.

The impressions of these round Particles was in several places so regular, that each consisted of six sides, dispos'd in the exactest order that can be imagin'd ; and in each Particle one might discover a Protuberance, and they were separated from one another by Rings or Circles, which I suppos'd to be the Canals.

I caus'd a small part of the foremention'd Hexangular Particles to be drawn just as it appear'd thro my Microscope ; see Tab. 2. Fig. 1. A B C D in which some of the Canals, in order to distinguish them the better, are represented outwards, as at A B C D.

When I examin'd farther into the Aloes Leaf, I discover'd another sort of Vessels or Canals, in which the Sap appear'd somewhat Reddish.

I took the Sap out of the said Vessels, to try whether there were any Salt Particles therein, and what Figure they were of.

I let this Sap stand a little that some part of it might evaporate, and the Salts coagulate, and placing some of it before my Microscope, I observ'd with wonder a great number of long, slender Particles, that lay in the Sap, and were sharp or pointed at both ends; and forasmuch as I imagin'd that these long Particles could not be coagulated in that small time that the Sap was prest out of the Canals, but rather that they were there before, I endeavour'd to bring the said long Particles out of the Vessels, so that there should come very little Sap with 'em, that the Painter might see them more distinctly; which having brought to pass, I caused a few (out of several hundreds that in a short time I had heapt together) to be described, as you may see in Fig. 2. E F G H.

The said slender Particles appeared thro the Microscope very clear and transparent; I laid them upon a clean Glass plate, and viewing them about three weeks after, I saw with wonder that some of them had assumed a Peach color, and especially such as lay close, or upon one another.

My next Attempt was to know how these sharp Particles were ranged or placed in the Vessels, and whether they were to be found in all Canals.

At last, after several Observations, by Breaking and Cutting in pieces the Aloes Leaves, I brought my matters so far to bear, that I placed them so nicely before the Painters Eye, that he could not only see the foresaid long pointed Particles lying in those Rings or Circles, which I imagin'd to serve for Canals, as in Fig. 3. I K L M, in the middle of five rows between I and K; but I caused
him

him also to observe how that a small piece of Leaf was separated by me after such a manner, that the Ends or Points of those sharp Particles stretcht themselves beyond the Canals, as is here represented in N and O.

These Sharp Particles lay within a small compass, like little Bundles, as is shown in the figure, but they don't all lye in such order, nor always so close to each other, but at a greater distance in several places, and sometimes indeed closer too : Now you must take notice that Fig. 3. I K L M, as it appears to the naked Eye, did not cover more Space than a large Grain of Sand ; from whence we may guess what an infinite number of such Sharp Particles are included in one Leaf of Aloes ; in this Figure, or in each of these Particles, are a great many parts to be seen which seem to be Canals ; and I suppose moreover, that each Circle, or the Membranes thereof, in which the Sap, and othet Parts are shut up, are also full Canals.

Next, we proceed to the Vessels or Canals, which lye something deeper in the Leaf, and of which I have made some mention before ; these also I set before the Painter, who has delineated them as in the following Figure.

Fig. 4. A B C D E F G H I represents one of the inward lying Vessels or Canals, which is in a manner surrounded and involv'd in a sort of Matter, which one would take to be a Viscous or Slimy Matter, and which, as well as I was able, I endeavour'd to separate from it ; from these Vessels or Canals in four distinct places (and all in a very little space) there proceeded kind of Branches, as two between D E F G, and two between H I, which run cross from the Leaf.

These Twigs or Branches unite themselves again in one Vein or Canal that lies just by 'em, which is not near so great as the first mention'd Canal, and this Union

or Conjunction is described by K L M N O P Q R, and there are three such Small Canals to one Great one.

Yea, the said Vein or Canal that runs across is not only joyn'd to a Second ascending Vein, which extends it self the length of the Leaf, but it goes farther, and falls into a third Canal, which also runs the length of the said Leaf, as may be seen in the same Figure by S T V W X Y Z a; and who knows but if one could investigate the conjunction of the Vessels, that this order runs through the whole Leaf.

I fancied with my self, that some of these Veins or Canals were compos'd of long Particles, that extended themselves parallel, and very near to each other, but in a Winding and Serpentine motion, to the end that the said Veins should never fall in with one another, but always remain open and distinct; and agreeably to this opinion, I have sometimes, but very seldom, taken those parts out of the Canals, so that the Painter could draw them after me.

In the said Fig. 4. by W B C D E F X is represented the last mentioned Particle which makes a Canal, but of a very small length, and seems to be of a flattish shape, as between W and B; but viewing it more narrowly, we found that the seeming Flatness was occasion'd by the Canals lying so close to each other; for we saw clearly that B was two distinct Canals when they were stretcht out, as in B C F; and that one of those Canals was again subdivided into two more, as from C to D; and the Painter judg'd that those slender Particles D and E still spun themselves into more subdivisions.

Now one can't come at a sight of these last mention'd Parts by cutting the Leaf through, but you must tear it in pieces; and even then for the most part these Canals, with the foresaid particles, will be also broken before one can get a sight of them.

I have

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I have view'd those winding Particles that lye in the Canals or Vessels of other Leaves, when they were so exceeding small and fine, that it was as much as one could do, with a sharp Eye and a good Glass, to perceive their Meanders, or Serpentine Motion.

After this I took that particle of the Aloes-leaf which I had before examin'd lengthwise, and cut it across, and view'd it in that position, that I might discover the Orifices or Openings of those Canals that in Fig. 4. are described in their whole length by A B C D.

In Fig. 5. H I K L are represented (as they appear'd thro a Microscope that did not enlarge the object so much as that thro which I view'd Fig. 1. and 2.) six great Tubes, which show themselves in the last mention'd Vessel or Canal, in which also there are a great many other lesser Pipes.

Those smaller Pipes or Vessels, which are to be seen about H, have other cross Canals that come out of 'em, from whence proceed the inward-lying great Membranes, with the Sap that is in them.

Fig. 6. M N O Represents other Canals that were also cut across, and in Fig. 7. A. is also shown by P Q R, how out of the Canals so divided the Membranes proceed, in which most of the Saps are included, and of which Membranes the greatest part of the Aloes-leaf is compos'd; and those Membranes, with the Saps that lye in 'em, are so clear and transparent, that you can see nothing but their Circles or Circumferences, as in R Q S T V W X P.

Between these Membranes there are Canals, but very few, with their Branches, that run the length of the Leaf, from whence also the Membranes proceed; and when I took one of these Vessels or Canals surrounded with Membranes, and the Matter shut up in them, and separated a little of it from those other afore-mention'd parts, so that it was expos'd naked to the Air, it assum'd presently after a Red Colour, whereas those parts that were

were involved in their Membranes kept, which was a little upon the Green.

This change from Green to Red puts me in mind of what I have observ'd several times in the Eggs of a living Crab, which I have taken out of her, and breaking them in pieces, view'd them, and perceived that the Matter which lay in the Egg-shells was Green; but when I let it dry a little, it presently turn'd from Green to Red.

I cut the great Canals of another Aloes-leaf, across which appear'd Yellow, as did also the Sap which came out of the inward lying Membranes; and when I cut a Slip or Slice of such a Leaf, which was as thick as the back of a Knife, and laid it upon a Clean Glass Plate, it turn'd presently to a Peach colour, from Yellow as it had before, and so did a small drop of the Sap upon the same Glass; which being almost dry'd up, there appear'd as many Salt Particles in that little Matter, as if the fourth part of it had been mixt with Shining Sand.

I took a little of the aforesaid Sap, and put it upon my Thumb-nail, and let it dry there, and observ'd that it left a Yellowish Colour behind it, that the Particles of Salt had coagulated upon my Nail after the same manner as a Foggy moisture is congealed in Winter on Glass-Windows; and the next day I perceiv'd a Reddish Colour where the Sap had lain, and where it had been thickest the Red was deeper, which we call a Peach Colour.

I tryed the same experiment upon two other Nails of my Hand, and the success was the same, and the Colour lasted several days.

I cut a small Splinter of the Wood, in which there had been some Sap of the Aloes, but in which at that time there was but little Color to be seen, and placing it before a Microscope, I saw that it gradually assum'd a Peach Colour, which in some places was as bright and as fine as I ever beheld with my Eyes.

I thought fit to cut off a Slice of the Aloes-leaf from the thickest part of it, which appear'd in Fig. 8. A B C, which Letters represent the side of the Leaf, that, as I imagin'd, was next the Plant; like as C D A the other side, which one would take to be the Back of the said Leaf.

That part of the Leaf which we may look upon to be the Skin or Rind of it, and in which the Parts represented in Fig. 1, 2, 3 and 4, are for the most part shut up, is the Space which is describ'd in Fig. 8. between B F, or D H; and between E F G H lies the fore-mention'd Matter, that I liken'd before to a Slimy or Viscous Substance.

As for what concerns the farther texture of the two particular Aloes leaves, and the Sharp Particles represented by Fig. 2, and that Matter in the great Canal, which was at first Yellow, and soon after turn'd Red; I could not discover in the said Viscous Matter any Vessels that run thro the middle of it, like those which proceeded out of the great Canals, and spread themselves to the innermost parts of the Leaf, and were exceeding small and numerous.

I placed another Slice of the Aloes-leaf (which was also about the thickness of the back of a Knife) upon a clean Glass, and view'd it several times, for the sake of the fine Peach Colours that were to be seen in it; and I observed in the same, a kind of an oval Figure, that lay in exact order, with its Sap shut up in it, after it had been dry about 3 weeks.

I order'd the Painter to draw it, as you may see in Fig. 7. B. D E F G H, which shows the said Oval Membrane; and F I G describes that part which I call the Canal, and by which I suppose it is made big, and also receives its inward Matter.

In this Figure one sees a great many Fibres, which I concluded it had borrow'd from other Membranes, as well

well from those that lay upon it, as from those that lay under it.

Now if we consider that these Membranes can't be coagulated by the Air, since they are not made by every Evaporation or Exhalation of the moisture, but that such Membranes must be compos'd (without doubt) of an infinite number of Fibres, so small that they escape our sight, we have fresh cause to stand amazed, and to say with our selves, what unconceivable Wonders are shut up in such a Leaf.

I thought it not amiss to represent a small Particle of what I call'd the Rind or Bark of the Leaf, as it was cut through across, and dry'd up irregularly.

Fig. 7. A. by R P A B C S Q R shows a small part of the Leaf, as it was cut off at Fig. 8. between D H; and which part, with S Q R P A, lay inwards, as is described in Fig. 8. by H; and in the same Fig. 7. A. lay on the outside of the Leaf, as is shewn by B C.

Now these parts which in Fig. 7. A are cut across between A B and C S, are the very same parts which in Fig. 3. I K L M are represented lengthwise, with this difference only, that Fig. 7. A. is drawn from a less Microscope.

One would judge that most of the afore-mention'd Parts are compos'd of roundish Membranes, that include a Sap, which Sap was mingled with exceeding small green Particles, and those Particles are so united to each other in right lines, that there is no space between them, excepting that which appears to be Canals.

I told you above, that I had squeez'd the Sap out of the Aloes Leaf, in order to discover what Salt-particles would coagulate in the same.

I placed therefore the said Sap upon my Scrutore several times, and always observed that when the Water was mostly evaporated, there remain'd abundance of Salt particles behind, which were almost all of 'em Quadrangular

gular Figure, and of a Cubical thickness, as is represented in Fig. 9 between I K. and again some smaller, as Fig. 10. between L M and others much smaller, as in Fig. 12. nay, some of them were of that degree of smallness that they almost escap'd the sight, even with the help of a Microscope, insomuch that one could not judge whether those Salts were round or square.

I observ'd also some Figures of Salt that were compos'd of several coagulated after such a manner that their shape or form was not to be describ'd; and amongst others there was one Salt Particle that was compos'd of four others, joyn'd together foursquare cubically, as is described in Fig. 13. between N and O. I saw another Salt likewise, that was made up of twenty quadrilateral Salt particles coagulated together, to wit, five in length and four in breadth; and another Salt, in which I counted 30 Particles joyn'd after the same manner.

When I took the Sap out of an Aloes Leaf, whose Vessels had a Yellow Sap in them, I saw the Salt particles lying so clear, as if they were little pieces of Glass; and forasmuch as these Salt particles lay surrounded with a fine Peach colour, the View of it was very agreeable to the Eye.

From my Observations on the said Salts, my thoughts wander'd upon the Aloes it self, as it is used in the Apothecary's Shop.

Having then taken a piece of Aloes, and beat it small, being wrapt up in a Paper, and put it into a Clean Glass, pouring Rain-water upon it, in which I let it infuse 2 or 3 days, I pour'd off the top of it, and caus'd it to Evaporate, and then discover'd a great number of Salt particles, of the same shape and proportion as is described by Fig. 10, 11, 12, and 13.

There were also coagulated a great many Salt particles, that were of such a figure as is represented by Fig. 2. EFGH; only with this difference, that they were
M m m m m m m m m some-

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Something thicker and shorter also in the middle, and some of 'em not so even or smooth as in the said Fig. 2.

The said *Heer Hottot* sent me also a little Plant of Dragons Blood, in *Latin*, *Lapathum Sanguineum*; in which I view'd the Stalk of the Leaf after I had cut it across, and discover'd at the same time several particular Colours of a light and of a deeper Red, more than one, could imagine to see at one view: and I did observe in the said Stalk little places in which I could perceive no Colour; but when I cut the same Stalk lengthwise I could then see that those places were Canals, through which I concluded the Red Sap pass, and that those many Colours which lay in those Canals were a sort of Bladders, that contain'd the Sap in them, and that those several Colours were wholly produced by the Sap that ouz'd thro the sides of the Canals, and so made the whole Stalk Red.

V. *A Letter from Mr Antony van Leeuwenhoek, F. R. S. to John Chamberlain, Esq; S. R. S. concerning Tobacco ashes.*

Delft, Octob. 3. 1704.

I Take the Liberty to acquaint you, that soon after I had communicated to you my Poor Observations about a Tooth which was thought to have Worms in it, &c. I again examin'd the Ashes of Tobacco; and since the Remarks upon that subject are fallen into my hands within these few Days, I have taken the Liberty of sending 'em to you; hoping there may be something in em which may serve to divert you: The said Remarks are as follows. For

Tab: 1.

fig: 4.
K & I

fig: 2.
D

fig: 3.
H & G

fig: 1.
B & A

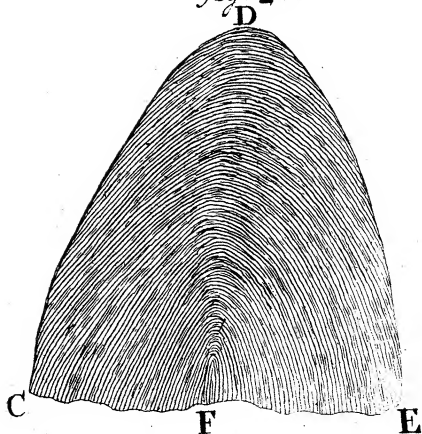
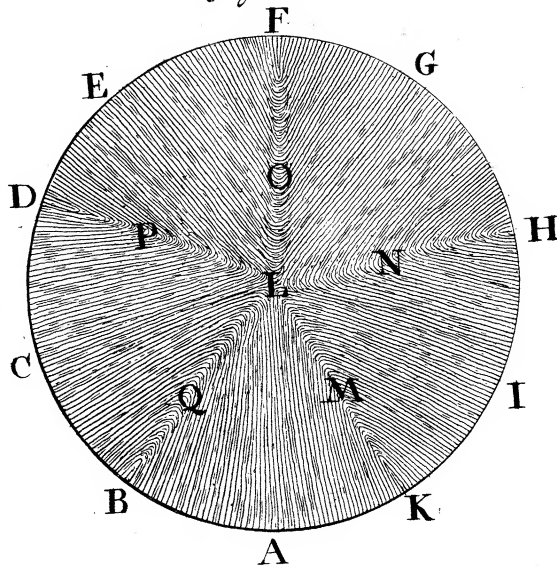
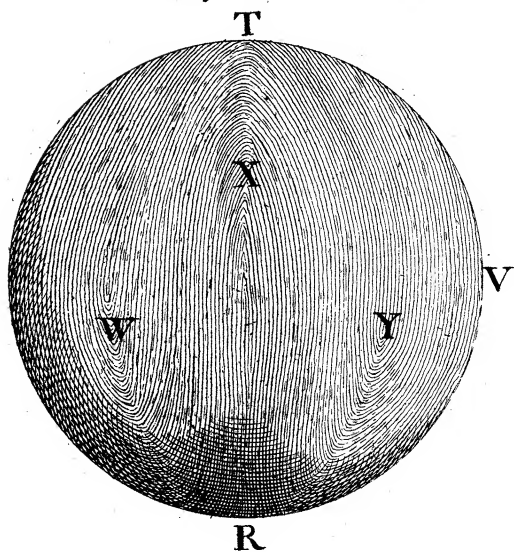


fig: 6.
T

fig: 5.
F



Tab: 3.

fig: 4.
K & I

fig: 3.
H & G

fig: 2.
F & E

fig: 1.
B & A



fig: 8.
S & R

fig: 7.
Q & P

fig: 6.
O & N

fig: 5.
M & L



fig: 12.
Z & Z

fig: 10.
W & V

fig: 9.
W & V

fig: 11.
Y & X



fig: 7. A

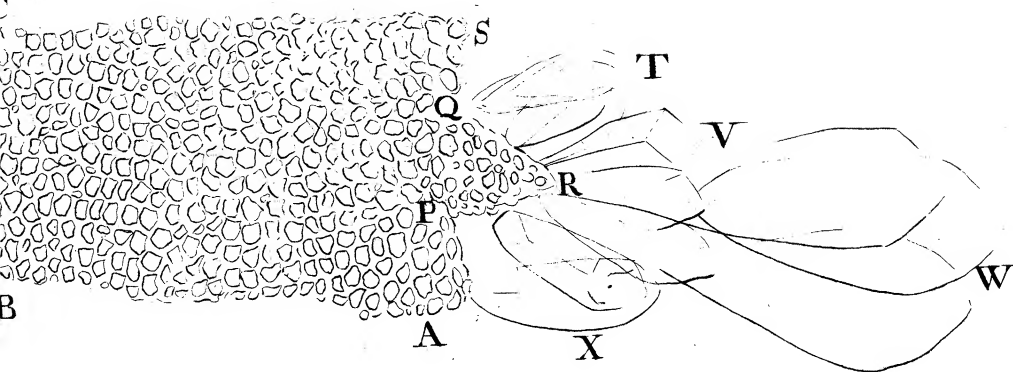


fig: 8.

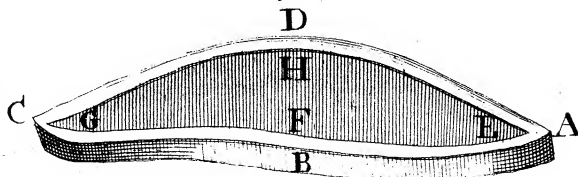


fig: 13.



fig: 12.



fig: 11.



fig: 7. B

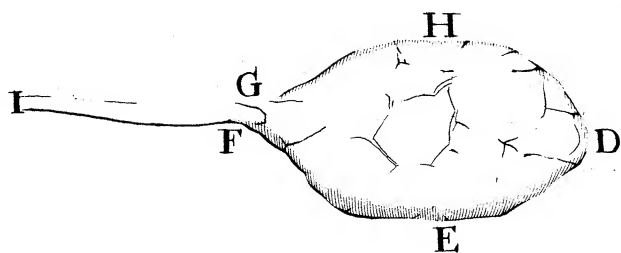


fig:3.

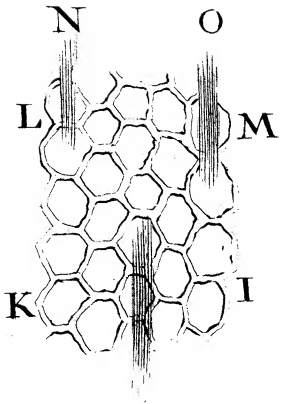


fig:2.

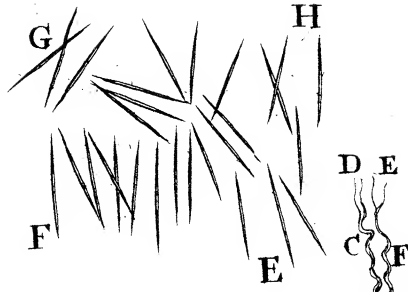


fig:1.

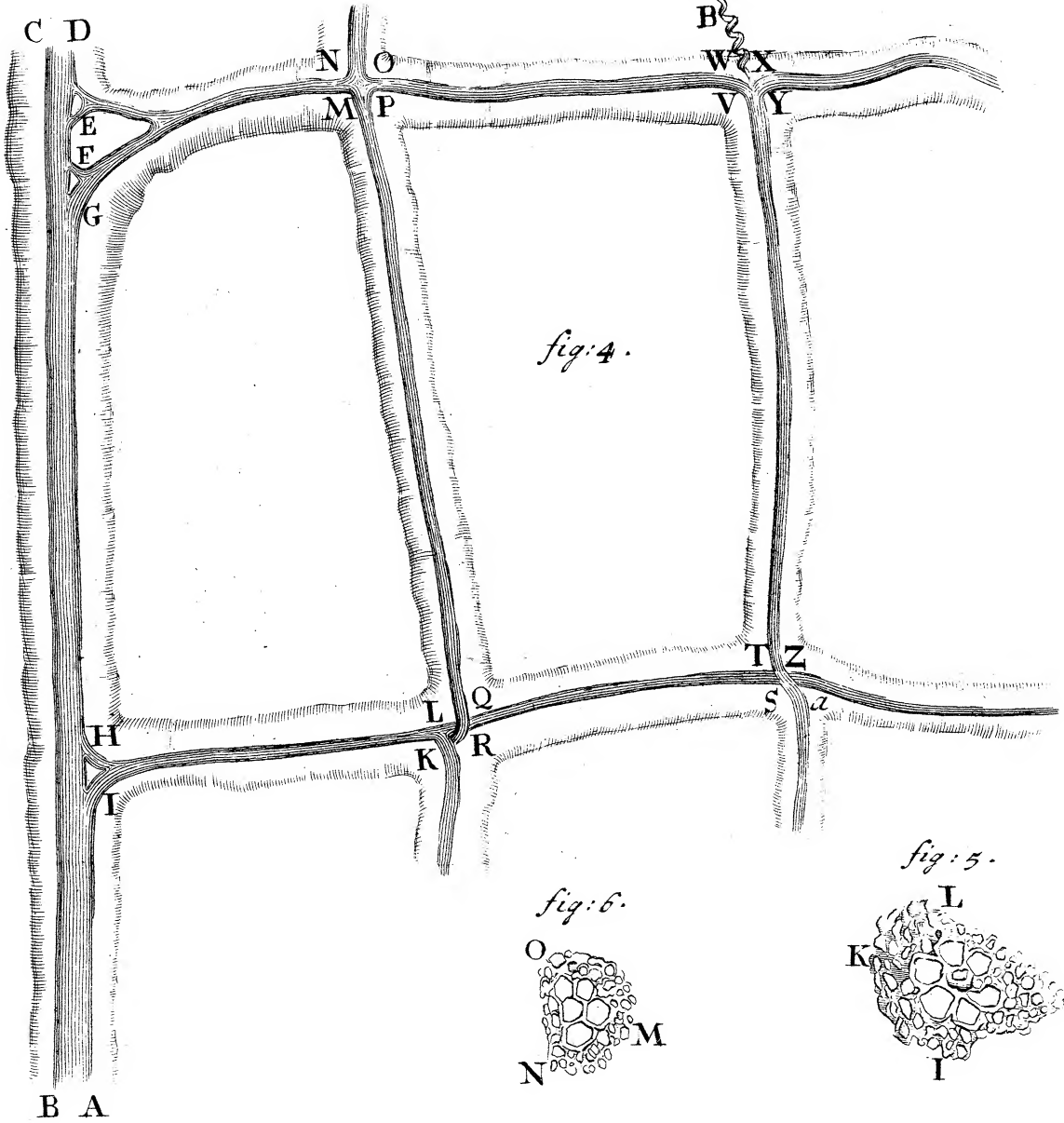
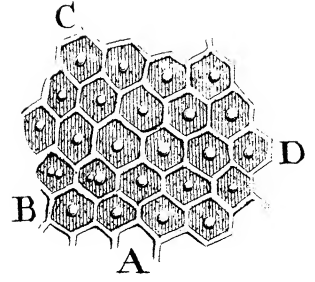


fig:6.

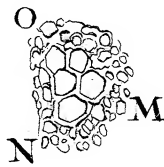
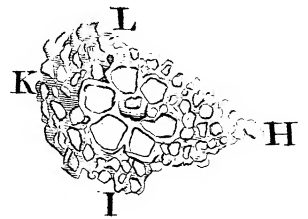
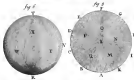


fig:5.



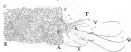
Tab. 1.



Tab. 2.



Fig. 17.



Tab. 3.

